the first opening **56** has a shape that is different than the second opening **58**. The first opening **56** also has a larger cross-sectional area than the second opening **58**.

[0023] The first opening **56** has a bi-lobed shape that is shown in greater detail in FIGS. **4** and **5**A-**5**C. This bi-lobed shape with the increased cross-sectional area improves cooling effectiveness. The bi-lobed shape is defined by a base portion **60**, a first lobe **62** extending away from the base portion **60** in a first direction, and a second lobe **64** extending away from the base portion **60** in a second direction different than the first direction. The bi-lobed shape also includes an arcuate portion **66** that extends from each of the first **62** and second **64** lobes toward the base portion **60** to a center **68**.

[0024] The base portion **60** has a first width and the first **62** and second **64** lobes extend away from each other to define a second width at distal tips that is larger than the first width. The lobes **62**, **64** are formed such that the second width is orientated in a direction that is transverse to streamwise flow over the airfoil **32**.

[0025] The first opening **56**, which has the bi-lobed shape, is defined by a center of origin **70**. The first lobe **62** is defined by a first radius R**1** that extends from the center of origin **70** outwardly to a curved distal tip **72** and the second lobe **64** is defined by a second radius R**2** that extends from the center of origin **70** to a curved distal tip **74**. The center **68**, which is a segment of the arcuate portion **66** that is closest to the center of origin **70**, is defined by a third radius R**3** that extends from the center of origin **70** to the center **68**. The first R**1** and second R**2** radii are greater than the third radius R**3**.

[0026] The base portion **60** of the bi-lobed shape is defined by a first segment **60***a,* a second segment **60***b* on one side of the first segment **60***a,* and a third segment **60***c* on an opposite side of the first segment **60***a*. The first segment **60***a* is defined by a fourth radius R**4** extending from the center of origin **70**, the second segment **60***b* is defined by a fifth radius R**5** extending from the center of origin **70**, and the third segment **60***c* is defined by a sixth radius R**6** extending from the center of origin **70**. In the example shown, the first R**1** and second R**2** radii are greater than the fourth R**4**, fifth R**5**, and sixth R**6** radii.

[0027] The cooling hole **50** transitions from the bi-lobed shape at the first opening **56** into a second shape that extends through the airfoil **32** to the second opening **58**. The shape of the second opening **58** corresponds to this second shape. In the example shown, the second shape is circular. The circular shape portion of the cooling hole **50** is shown more clearly in FIGS. **5**A-**5**C.

[0028] As shown more clearly in FIGS. **4** and **5**B, the second shape comprises a circle C having a center that defines the center of origin **70**. The circle is further defined by a seventh radius R**7** that extends outwardly from the center of origin **70**. In the example shown, this seventh radius R**7** is less than radii R**1**-**6**.

[0029] The lengths of the various radii R**1**-**7** can be varied to optimize cooling hole configurations for a specified gas turbine engine component. Each cooling hole **50** has a bi-lobed shape as described above, however, the dimensions of the various radii R**1**-**7** can be adjusted as needed to provide more effective cooling for different types of components. As different gas turbine engine components have different flow characteristics depending upon an associated application, the dimensions of the cooling hole **50** can be optimized to size the cooling hole **50** for the best performance for the specified component.

[0030] An example of the optimization process is shown in the flowchart of FIG. **6**. First a plurality of input parameters are defined as indicated at **100**. These input parameters can include wall thickness W of the component, pitch distance P, radial β and streamwise a angles that define orientation of the cooling hole, diameter D of the circular portion of the cooling hole, and control radii R**1**-**6** that define the shape of the first opening **56**. Typically, the control radii R**1**-**6** and diameter of the circular portion of the cooling hole are variable input parameters, with the remaining parameters being fixed for a specified component. These input parameters provide a parametric hole shape model that allows the shape of the hole to have an arbitrary shape subject to certain manufacturing constraints. One example of the input parameters is as follows: diameter D=0.020 inches; streamwise angle $\alpha=30°$; radial angle $\beta=0°$; pitch distance P=0.100 inches; and wall thickness W=0.050 inches.

[0031] Once the input parameters are defined, the control radii R**1**-**6** values can be varied or modified as needed to generate an initial hole configuration, as indicated at **110**. Once a first set of control radii R**1**-**6** have been entered, a geometry generation step is performed as indicated at **120**, and a grid generation step is performed as indicated at **130**. The geometry and grid generations are well known processes and will not be discussed in detail. The result of these steps is a component model with a first proposed hole configuration.

[0032] Next, as indicated at **140**, an automated computational fluid dynamics (CFD) process is launched to analyze the component with this specified hole configuration. Again, CFD processes are well known and will not be discussed in further detail. The results of the CFD processes are then analyzed at **150** to determine characteristics such as pressure loss and cooling effectiveness, for example. This post processing is integrated with the parametric hole shape set forth defined by steps **100** and **110**, which assesses the advantages of each hole parameter setting. Based on the analysis, the control radii R**1**-**6** can be adjusted or modified as indicated at **160** by returning to step **110**. During this step, the hole parameters are iterated with a numerical optimization algorithm that searches for the best combination of parameter settings that maximize film coverage/effectiveness. Each modification to the control radii R**1**-**6** results in a different hole configuration, which is separately analyzed. Each configuration is then ranked as indicated at **170** and an optimum configuration is identified at **180**.

[0033] It should be understood that the above discussed method for shape optimization, and the corresponding use of the specified control radii, are just examples. The bi-lobe shape could be defined by fewer or more radii than that discussed above. Further, the optimization process that is shown in the flowchart of FIG. **6** is just one example of a process for optimizing a shape; other processes could also be used.

[0034] The cooling holes **50** can be easily formed within an associated component by using rapid electrical discharge machining (EDM), laser cutting, or other similar high precision cutting processes. By using these types of methods, shaped holes can be formed within a component in a cost effective manner.

[0035] Further, the bi-lobed shape of the cooling holes provides significant improvement in film effectiveness com-